

# Aperture: A Precise Extremely large Reflective Telescope Using Re-configurable Elements

Completed Technology Project (2015 - 2016)



## Project Introduction

Northwestern University, teamed with the University of Illinois (UIUC), proposes to develop a game changing technology for large deployable optical quality mirrors. The innovation combines the concept of a flying magnetic write head with a magnetic smart material that coats the back of the mirror. Northwestern Univ. will work on the materials and shaping the mirror with a magnetic field. UIUC will work on coupling the deployment design to a flying magnetic write head design. Deployable and deformable reflecting membrane mirror have been worked on in the past, but so far the ability to provide post deployment figure corrections to the level of  $\lambda/20$  has eluded the space community. The Phase I NIAC proposal will identify possible solutions to the main problems, such that a Phase II will take the program to TRL 3 or beyond. Some of the hurdles will be coating in such a way that the coatings (front and back) do not distort the mirror beyond our ability to correct. Another hurdle will be ensuring that the corrected mirror retains its shape for significantly long periods of time thereby minimizing the frequency of routine mirror maintenance.

## Anticipated Benefits

Engaging the public: Northwestern has ties to Adler Planetarium that will give the potential both for public lectures as well as displays that reach over 500,000 visitors and over 90,000 students and teachers each year. Also, both UIUC and Northwestern engage the public in open lecture to their surrounding communities. The outcome of Phase I will produce drawing and schematics perfect for presentations and displays at the respective campuses and at Adler.



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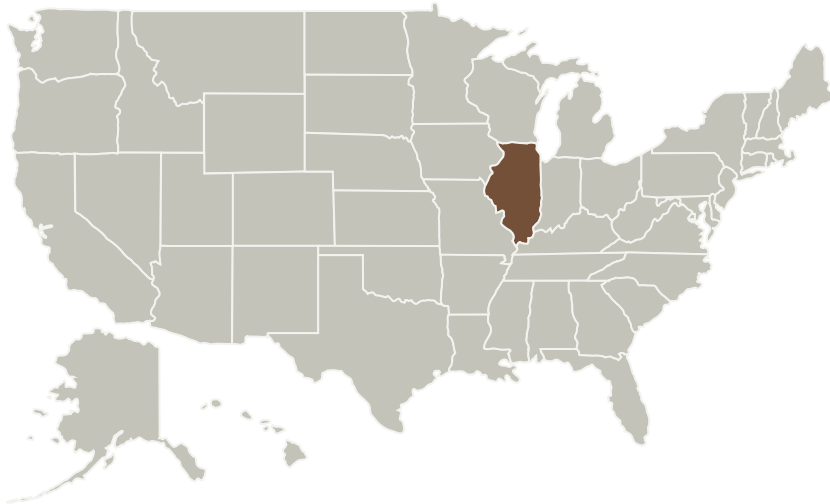
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## Primary U.S. Work Locations and Key Partners




Organizations Performing Work	Role	Type	Location
Northwestern University	Lead Organization	Academia	Evanston, Illinois
University of Illinois at Urbana-Champaign	Supporting Organization	Academia	Urbana, Illinois

### Primary U.S. Work Locations

Illinois

## Project Transitions

 **July 2015:** Project Start

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Northwestern University

### Responsible Program:

NASA Innovative Advanced Concepts

## Project Management

### Program Director:

Jason E Derleth

### Program Manager:

Eric A Eberly

### Principal Investigator:

Melville P Ulmer

### Co-Investigators:

Victoria L Coverstone

Jian Cao

Yip-wuah Chung

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## ✓ June 2016: Closed out

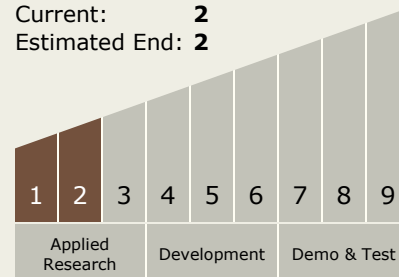
**Closeout Summary:** The goal of this Phase I study is to establish that the APERTURE mission presents a feasible approach toward the reality of deployable diffraction-limited ultraviolet-visible (UV-Vis) mirrors of 16-m diameter or larger. APERTURE, which stands for "A Precise Extremely large Reflective space Telescope Using Reconfigurable Elements", uses a Magnetic Smart Material (MSM) to apply figure corrections to extremely large (16-m) deployable reflective optics. The first step of the deployment will utilize an umbrella-like structure and MSM to achieve a parabolic shape for the optics. The inside of the umbrella will be the reflective surface, while the outside will be coated in MSM. A magnetic write head will move to different locations on the MSM coated side to manipulate the MSM, changing the shape of the optics and eliminating any deviation from the desired final shape. Figure 1 depicts the concept of APERTURE: the write head (in dark gold color) moves along the curved arm, while the curved arm rotates about the center axis.

## Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

## Technology Maturity (TRL)

Start: **1**  
Current: **2**  
Estimated End: **2**



## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.2 Observatories
    - └ TX08.2.1 Mirror Systems

## Target Destinations

The Moon, Others Inside the Solar System